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U.S. PATENT APPLICATION SERIAL NO. 09/504,623
DOCKET NO. 2369/25

The Office Action rejects claims 1, and 18-23 under 35 U.S.C. § 103 over Johnson (USP 5,654,566) in view of Hayashi (USP 5,365,078). This rejection is respectfully traversed.

Claim 1 recites a magneto electric device responsive to an applied magnetic field comprising first and second ferromagnetic regions with a channel region between them, the ferromagnetic regions being configured so that charge carriers with a particular spin polarization can pass through the first region, pass through the second region as a function of the relative orientations of magnetization of the ferromagnetic regions produced by the applied magnetic fields, whereby the device exhibits a conductivity as a function of the strength of the applied field, the channel region being configured to provide a quasi-one-dimensional channel to cause charge carriers which pass through the first ferromagnetic region to maintain their spin polarization as they pass towards the second ferromagnetic region. The Office Action admits that Johnson does not teach a quasi-one-dimensional channel as recited in claim 1. The Office Action asserts that Hayashi teaches a quasi-one-dimensional channel and asserts that it would have been obvious to modify the device of Johnson to include the quasi-one-dimensional channel taught by Hayashi because a higher speed and lower noise operation can supposedly be achieved by using a quasi-one-dimensional channel rather than a quasi-two-dimensional channel.

The inventors of the present invention found that when the oxide layer of the prior art is replaced by a quasi-one-dimensional channel, electrons with a spin orientation produced in a ferromagnetic region maintain their spin direction as they pass into a second ferromagnetic region so that when the regions and their spin orientations are antiparallel, a much higher resistance occurs, significantly improving the distinction between the high and low resistance states for the device. In a preferred embodiment of the invention, the channel comprises a nanotube, as recited in claim 2. It came as a surprise to the inventors that the use of a quasi-one-dimensional channel should give rise to such an improved result. It is not evident to those skilled in the art that the use of a one-dimensional channel should maintain the spin orientation of the electrons as they pass between ferromagnetic regions 3 and 4. On the contrary, it might be expected that the spin of the electrons would interact with the applied field to change the spin direction.

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The Office Action asserts that it would have been obvious to make use of a one dimensional channel in the device of Johnson by citing Hayashi. However, Hayashi does not indicate that the use of the one-dimensional channel would preserve electron spin polarization, but instead discusses the electrons scattering that may occur in a 2DEG, and teaches that such scattering is reduced when a one dimensional channel is used. However, this should not be confused with electron spin scattering. The scattering discussed by Hayashi concerns the momentum or velocity vector for the electrons concerned rather than their spin vector and it is not inevitable that scattering in the electron momentum will produce the change in spin.

Further, the Examiner cites Hayashi at column 6, lines 22-24 as asserting that the one dimensional channel will achieve high speed, low noise operation. However, there is no teaching that the use of such a one dimensional channel would improve the speed or noise operation of the device of Johnson. Further, it is noted that Hayashi actually requires that the electron supply layer 33 has a sufficient thickness so that when a gate bias applied to the gate electrode forms a shallow electron gas layer, electron gas within the channel layer is two dimensional as shown in Fig. 4A, and that when the gate voltage is larger than the certain magnitude, the channel layer 32 has a fine line structure so that the electron gas beneath the valleys of the gate electrode is confined in the wide direction to make the electron gas 1-dimensional. See col. 5, lines 33-51. As can be seen with reference to Fig. 4, the layer between the gate electrode 122 and the channel 112 of Johnson is standard on both of those layers in sharp contrast to element 33 of Fig. 4A of Hayashi which has much thicker layer beneath the gate electrode. In fact, Johnson indicates that in the embodiment of Fig. 6 which shows more details of the device, the insulating layer 202 is 40 nm thick, while the gate 206 is 60 nm thick, with a much thicker channel region. See col. 11, lines 57-62. The Office Action has failed to demonstrate that the device of Johnson would function a quasi-1-dimensional channel or that such a quasi-one-dimensional channel would in any way improve the device of Johnson. It is further submitted that the Examiner has not considered Johnson and Hayashi as a whole, but rather has artificially split each of these into parts where the Examiner picks and chooses the necessary elements to combine. Furthermore, the Examiner

has failed to demonstrate the desirability and thus the obviousness of making combination of the two applied references, but has instead combined them using hindsight reconstruction.

It is respectfully asserted that there would have been no reasonable expectation of success when including the quasi-one-dimensional channel of Hayashi into the device of Johnson. There is no suggestion in the art of record that the use of a quasi-one-dimensional channel will result in a maintenance of electron spin. On the contrary, a reasonable expectation would be for the electron spin to be disturbed in the presence of the magnetic fields.

For at least these reasons, it is respectfully submitted that claim 1 and of the claims dependent therefrom would not have been obvious over the cited references. Withdrawal of the rejection is respectfully requested.

The Office Action rejects claims 2-7 under 35 U.S.C. § 103 over Johnson in view of Hayashi and further in view of Tsebro et al., rejects claims 9, 10, 13-15 and 25 under 35 U.S.C. § 103 over Nakatani in view of Tsebro. Claims 9 and 10 have been canceled so this rejection is moot with regard to these claims. This rejection is respectfully traversed regarding claims 13-15 and 25.

As explained above, Johnson in view of Hayashi do not render obvious claim 1, from which claims 2-7 depend. Further, Tsebro does not remedy the above noted deficiencies of Johnson or Hayashi and accordingly, these claims would not have been obvious. Withdrawal of the rejection is requested.

The Office Action rejects claims 9, 10, 13-15 and 25 under 35 U.S.C. § 103 over Nakatani in view of Tsebro, rejects claims 11-12 under 35 U.S.C. § 103 over Nakatani and rejects claims 16-17 under 35 U.S.C. § 103 over Nakatani in view of Tsebro and further in view of Glatkowski (USP 6,265,466). Claims 9 and 10 have been canceled and the rejection is moot with regard to these claims. These rejections are respectfully traversed for claims 13-15 and 25.

Nakatani discloses a device that operates according to the prior art principles discussed in the background section of the present application. It includes a conventional overlying parallel or antiparallel ferromagnetic layers separated by an intermediate layer of insulating silicon dioxide. The intermediate layer acts as a tunnel barrier between the

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ferromagnetic layers that electrons tunnel through. Nakatani does not disclose the quasi-one dimensional channel. There would have been no motivation to combine this with Tserbo. Neither reference indicates that the use of the one-dimensional channel or a nanotube would preserve electron spin polarization. Accordingly, applicants request withdrawal of the rejection.

For at least the above reasons, it is submitted that the application is in condition for allowance. Prompt consideration and allowance are earnestly solicited.

Attached hereto is a marked up version of the changes made to the claims by the current amendment. The attached page is captioned "**Version with Markings to Show Changes Made**".

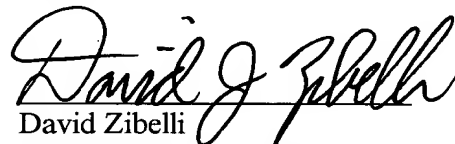
The Office is authorized to charge any fees due under 37 C.F.R. § 1.16 or 1.17 to Deposit Account No. 11-0600.

Should there be any questions concerning this matter, the Examiner is invited to contact Applicants undersigned attorney.

Dated: September 16, 2002

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please cancel claims 8-12 and 24.